

Performance Evaluation of Polymer Fiber “RECRON-3S” in Pavement Quality Concrete

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Abstract— Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation operations points towards the scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. But, there are also some problems outcomes with concrete pavement like micro-shrinkage, cracking, and low water permeability. To overcome this kind of problems, the secondary construction material “Recron-3S” is preferable to add in concrete for making stronger and batter road pavement. Present paper focuses how the compressive and flexural strength of the Pavement Quality Concrete (PQC) increases using Recron-3S fiber with compression test of the concrete. The testing results of the prepared sample cube with Recron-3S has compared with other samples which is without the mixture of the Recron-3S.

Key words: Recron-3S, Pavement Quality Concrete (PQC), Compressive and flexural strength

I. INTRODUCTION

A. Background- “Recron-3s”:

Research and development work in Fiber Reinforced Concrete (FRC) composites began in India in the early 1970s. Fiber reinforced concrete was developed to overcome the problems associated with cement based materials such as low tensile strength, poor fracture toughness and brittleness of cementations composites. In the beginning, FRC was primarily used for pavements and industrial floors but now a day FRC composite is being used for a wide variety of applications including bridges, tunnel and canal linings, hydraulic structures, pipes, safety vaults and structural members.

There are so many type of polymer fiber available as secondary construction materials, The Recron-3S fiber is one of them, and The Reliance Industry Limited (RIL) has launched Recron-3S. Recron-3s polymer fiber for mixing concrete and mortar for improving certain properties of the concrete and mortar. Fibers have special triangular shape for better anchoring with other ingredient of the mix. Recron-3S fiber is available in 6mm and 12mm length.

For the present study, existing model road project in Ghatlodia, Ahmedabad is used as a case study for the Checking the results for use of Recron-3s in Pavement Quality Concrete (P.Q.C.). We have collected the data from TUV SUD South Asia Pvt. Ltd. & Ashish infracon Pvt. Ltd. The compression tests (Automatic Testing Machine) had also performed in the laboratory of Ashish infracon Pvt. Ltd. Company on Recron-3S material mixing with cement concrete cube.

In present research, the compression test has been carried out on fiber material name as Recron-3S. The testing

results show that the compressive and tensile strength of Recron-3S mixing prepared cubes are increasing with comparison of the other R.C.C. Pavements. It is also found that the minimum crack is occurring under heavy load on this cube and this will decrease the water permeability.

II. OBJECTIVES OF THE PRESENT RESEARCH

The objective of the present study is to increase the flexural and compressive strength of the Pavement Quality Concrete (PQS) used in R.C.C. pavement construction. The aim of this study is also to achieve environmental friendly pavement concrete elements for pavement construction.

III. GENERAL INFORMATION ABOUT THE PRODUCT

A. General Details about Product:

1) Product Name:

Recron-3s Polypropylene Short-cut Fiber

2) Company/ Undertaking Identification:

Manufacturer: Reliance Industries Ltd. (Polyester Sector)

3) Use of the Product:

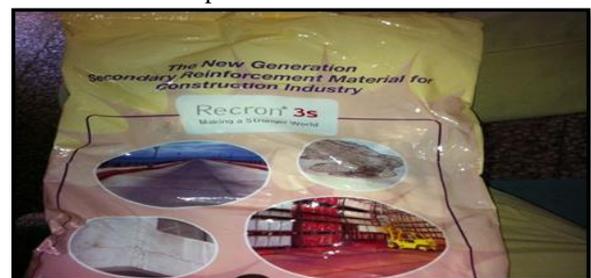
Reliance Industry Limited (RIL) has launched Recron-3s fibers with the objective of improving the quality of plaster and concrete. Secondary reinforcement fiber for concrete, in wet laid non- woven, paper and Lead acid batteries.

B. Environmental Precautions:

In case of accidental spills, do not allow entering drains and waterways. The sample of Recron-3S is shown in Figure-3.1. The physical and chemical properties are also shown in Table- 3.1.



Sample of Recron-3S Fibers



Recron-3S

Fig. 1: Samples of the Recron-3S Fiber

No.	Property	Value
1.	Diameter	0.4mm
2.	Cut Length	6mm or 12mm
3.	Tensile Strength	4000-6000kg/cm ²
4.	Denier	11.4-12.6
5.	Melting point	>250oc
6.	Tenacity	Min. 3.5 g/d
7.	Elongation	50-70%
8.	Dispersion	3-4
9.	Shape of fiber	Special triangle shape
10.	Pictorial view	

Table 1: Physical & Chemical properties of Recron-3S

C. Merits and Demerits:

1) Merits:

- Control cracking: It helps in controlling micro shrinking cracks in plastic stage.
- Reduces water permeability: Test results have confirmed that the use of recron-3s reduces water permeability of the Pavement concrete.
- Reduces rebound loss: Use of recron-3s reduce the rebound loss of mortar and concretes as confirmed by user feedback.
- Increases flexibility: Due to its high modulus of elasticity, recron-3s has found to be helping in increasing the flexural strength of Pavement concrete.
- Alkali resistance: Results have shown that recron-3s has acceptable range of alkali resistance.
- Maintenance: there is no special maintenance required with the use of Recron-3s fiber.
- Environmental: Recron-3s is environmental friendly.

2) Demerits:

- With the use of this product some extra weight is added in concrete and this will increase specific gravity of concrete and self-weight of structure.
- Adding of this product in Pavement concrete will increase the cost, so it is more costly than ordinary concrete.
- Using of FRC required highly skilled worker to finish the task in proper way.

D. Application:

Recron-3s fiber can be used in concrete element such as RC and PC lintel, Beam, column, flooring and wall plastering, foundation, tanks, manhole cover and tiles plastering, Road and pavement, hollow block and precast, Railway slippers, swimming pools.

IV. LITERATURE BACKGROUND

Over 400 million tons of waste materials are being produced by various industries every year all over the world Dharani et. al. (2013). Recron-3s is a polypropylene monofilament,

discrete, discontinuous short fiber that can be used in concrete to control and arrest cracks Dharani et. al. (2013). **Abtahi, Kunt, Hejazi and Ebrahimi (2014)** shows that polypropylene fiber modified bituminous concrete samples exhibits superior performance compared to other fiber reinforced samples. Polypropylene fibers decreases penetration and ductility of modified bitumen while the softening point value is increased compared unmodified bitumen specimen. They also suggested that Polypropylene (PP) fibers are preferred due to their low-cost and good consistency with bituminous pavement.

Ashish Kumar Dash (2011), Used Recron-3s fiber and silica fume for making concrete. The compressive strength and the flexural strength of the concrete specimens were determined. The optimum strength was obtained at 0.2% fiber content. Machine Hsie et. al. (2008) used polypropylene hybrid fiber for making concrete. It was reported that the strength of concrete with polypropylene hybrid fiber was better than that of the single fiber reinforced concrete.

Increasing the Polypropylene (PP) fiber dosage from 1 to 2 kg/m³, the flexural residual concrete behavior was not significantly improved L. A. P. L (2010). The flexural strength of the mix with the dosage of 1.5% increases by 21%. Hence increase in percentage of polyester fibers increases the flexural strength (Priti A. Patel- 2010).

V. STUDY AREA

Ahmedabad Municipal Corporation has started a new model road project in Ghatlodia, Ahmedabad. We have collected the project data from "TUV SUD South Asia Pvt. Ltd." like dimension of road, material used in this project, difficulty occur during the construction, how to use polymer fiber 'Recron-3s' in concrete, which kind of special care is required to use the fiber as a construction material, which type of machinery are use in this project. In the next step we have also visited the concrete mixing plant to know how to mix the fiber in concrete and what is mixing ratio. We have also collected the testing data form Ashish infracon Pvt. Ltd. Testing laboratory and also performed some tests on concrete cube with or without Recron-3S Fiber and compared them and also tried to know that which is more Beneficial for construction is. The study area stretch, photos at the time of construction of roads are shown in Figures- 5.1, 5.2 & 5.3.

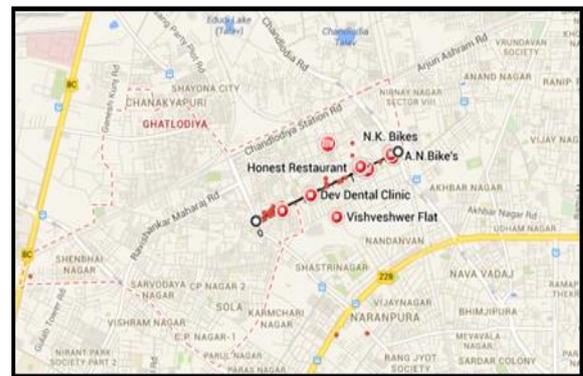


Fig. 2: Study Area Map

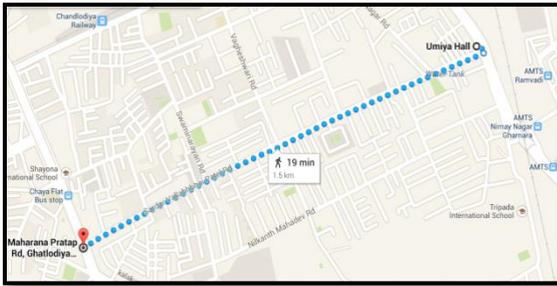


Fig. 3: 1.5 km Sardar Vallabhbhai Patel Road



Existing Study Area
Fig. 4: Study Area Stretch



Fully Automatic P.Q.C. Road Paver Machine
Fig. 5: Study area construction snaps

Construction of concrete pavement & allied works from Prabhatchaw to Umiya Hall Cross Road at Ghatlodia in Ahmedabad.



Fig. 6: Recron-3s fiber in concrete



Beam Mould



Preparation of Cube
Fig. 7: Sample Preparation of Cube

VI. ANALYSIS AND DISCUSSION

A. Mix Design:

In case of machine mixing, fiber are put in the mixer along with some water and then other ingredients are added and mixing is continued till entire fiber are dispersed in few minutes. In manual mixing, half the fiber are mixed and stirred in a bucket of water in case and then mixed with other ingredients, likewise added in the mix. Table- 6.1 elaborates the mixing ratio of Recron-3S with concrete and others.

No.	Application	General specification
1.	Plaster	6mm length at 125g/cement bag 1:4 cement/sand ratio
2.	Concrete	12mm length at 909gm/m ³
3.	Ready mix concrete	12mm length at 909gm/m ³

Table 2: Mixing ratio of Recron-3S

B. Sampling Preparation and Testing Of Beam and Cube:

Samples of dry lean concrete for making cubes shall be taken from the incompact material from different locations immediately before compaction at the rate of 3 samples for each 1000 sq. m or part thereof laid each day. The sampling of mix shall be done from the paving site. Test cubes of 150 mm size shall be made immediately from each mix sample. Cubes shall be made in accordance with the methods described in IS: 516 except that the cubes shall be compacted by means of a vibratory hammer with the moulds placed on a level and rigid base. Sample preparation of the concrete cube is shown in Figure- 6.1. At least three beams and three cube specimens, one set of three each for 7 day and 28 day strength tests shall be cast for every 150 cu.m (or part thereof) of concrete placed during construction.

In order to ensure that the specified minimum strength at 28 days is attained in 1 in 20 of all test beams, the mix shall be proportioned to give an average strength at 28 days exceeding the specified strength by 1.65 times the standard deviation calculated first from the flexural strengths of test beams made from the trial mix and subsequently from the accumulating result of flexural strengths of job control test beams.

C. Concrete Test and Results:

1) *Compressive strength and flexural strength of concrete:* Compressive strength and Flexural Strength of concrete is the most useful and important property of concrete. Many other properties of concrete such as durability, resistance to shrinkage, Young's modulus, imperviousness etc. are dependent on the compressive strength and Flexural Strength of concrete. The purpose of the compression test is to determine the crushing strength of hardened concrete. To measure the compressive strength, 6 cubes of size 150x150x150mm and to measure the Flexural Strength, 6 Beam of size 150mm x150mm x 700 mm were casted and tested were prepared and tested under Compression Testing Machine of 100-500 KN capacity under load control. The crack pattern at maximum load for cube having Recron-3S fiber. The average test results of the 6 cube specimens for compressive strength are presented in Table- 6.2. The preparation of testing machine of samples for flexural strength test and average results of this test is shown in Figure- 6.3 and Table- 6.3.



Fig. 8: Compression Test on Recron-3S Material mixing cube

Sample No.	No. of Days of Testing	Wt. of Cube (Kg.)	Load in KN	Compressive Strength (N/mm ²)	Avg. Compressive Strength (N/m m ²)
1	28	8.890	803.00	35.69	42.30
2	28	8.660	958.00	42.58	
3	28	8.760	915.00	40.67	
4	28	8.769	998.5	44.38	
5	28	8.670	1015.00	45.11	
6	28	8.790	1021.50	45.40	

Table 3: Results of Compressive Strength of Cube



Fig. 9: Testing of Flexural Strength of concrete Beam

Sample No.	Size of Specimen (cm)	Age of Beam Days	Distance of Fracture nearest support (cm)	Load in (KN)	Flexural Strength (N/m m ²)	Average (N/m m ²)
1	70x15x15	28	24	51	9.07	8.77
2	70x15x15	28	29	41	7.29	
3	70x15x15	28	27	55	9.78	
4	70x15x15	28	27.5	47	8.36	
5	70x15x15	28	29.5	49	8.71	
6	70x15x15	28	21	53	9.42	

Table 4: Results of Flexural Strength of Beam

D. Discussion:

The analysis shows that the compressive strength and flexural strength of the concrete cube are as 45.40 N/mm² and 9.78 N/mm². This strength is almost double of the testing results with the comparison of without Recron mixing material. It is also found that the minimum crack is occurring under heavy load and this will decrease the water permeability. Recron-3S is environmental friendly material. Usage of Recron-3s fibers will reduce the cost of maintenance by reducing the micro cracks and permeability and hence the durability will increase.

VII. CONCLUSION

Recron-3s polymer fiber for mixing concrete and mortar for improving certain properties of the concrete and mortar. Fiber has special triangular shape for better anchoring with other ingredient of the mix. Recron-3s fiber is available in 6mm and 12mm length. From the analysis of present project it is found that the using of Recron-3s in Pavement quality concrete will increase the compressive Strength and flexural strength. It is also found that the minimum crack is occurring under heavy load. And this will decrease the water

permeability. Recron-3S is environmental friendly material. Usage of Recron-3s fibers will reduce the cost of maintenance by reducing the micro cracks and permeability and hence the durability will increase. It is found that use of Recron-3s fiber reduces the segregation. It is found that addition of Recron-3s fibers have beneficial effects on the mechanical properties of concrete.

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